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ABSTRACT

This study examined two approaches to self-instruction by hearing-impaired students through use of instructor-developed science modules. Subjects were 24 students (ages 18-28) enrolled in allied health programs at the National Technical Institute for the Deaf. The first approach involved the reading of science modules and writing answers on study sheets. The second approach involved reading the same modules, but the students interacted with lessons on a computer for assessing comprehension, reviewing, and testing. Results indicated no differences between the paper-and-pencil groups and the computer-assisted instruction (CAI) groups on performance scores. The CAI groups took longer to finish the individual modules, but completed the set of nine modules in less time than the paper-and-pencil groups. It was concluded that the individualized, interactive feature of the computer appeared to motivate the hearing-impaired CAI groups to complete all the learning tasks sooner. (Includes 29 references.) (JDD)

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SELF-INSTRUCTION BY HEARING-IMPAIRED STUDENTS IN SCIENCE

by

DALE L. ROCKWELL, PhD

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ABSTRACT

There is a paucity of research in the development of reading materials and utilization of computer technology for learning science in the classroom. This study examined two approaches to self-instruction through use of instructor-developed science modules. The first approach involved the reading of modules and writing answers on study sheets. The second approach also involved reading of the same modules, but the student interacted with lessons on the computer for assessing comprehension, reviewing and testing.

A 2 x 2 factorial design was used to determine the effect of the two approaches and of language proficiency. The dependent variables were the test scores and learning time records obtained as the subjects interacted with the modules. An analysis of variance determined whether there was a difference in the scores and learning time records due to treatment, language proficiency and the interaction of treatment and language proficiency.

The results of this study indicated no differences with respect to treatment on the performance scores of the samples. A single main effect of language and three interactions were found for the ten performance measures. The Computer Assisted Instruction (CAI) groups took longer to finish the individual modules but completed the over-all task (the set of nine modules) in less time than the Paper-and-Pencil (P/P) groups. The individualized, interactive feature of the computer appears to motivate the hearing-impaired CAI groups to complete all the learning tasks sooner.

INTRODUCTION

Given the depressed reading skills of hearing-impaired students and the paucity of empirical data exploring new instructional approaches to learning science content, this study was designed to explore the effectiveness of computer-assisted instruction (CAI) for the learning of science vocabulary and science oriented mathematics computations by hearing impaired subjects. CAI has been shown through empirical research to produce positive results with normal hearing subjects that are distinguishable from traditional instruction (Burns & Bozeman, 1981; Kulik, Kulik, & Cohen, 1979; Kulik, Kulik, & Cohen, 1980; Kulik, Bangert, & Williams,, 1983). CAI has been consistently documented to accomplish learning in less time (Molnar, 1973; Cody, 1973; Jamison, Suppes, & Wells,, 1974; Edwards, Norton, Taylor, Dusseldorp, & Weiss, 1975; Thomas, 1979; Kulik, et al, 1980). In this study, student involvement with pre-selected science content was pursued using the Model of Classroom Instruction that evolved from the Beginning Teacher Evaluation Study (BTES) (Carroll, 1963; Fisher, Berliner, Filby, Marliave, Cahen, Dishaw, & Moore,1978; Fisher, Filby, Marliave, Cahen, Dishaw, Moore, & Berliner, 1978; Bright, 1983; Fisher & Berliner, 1985). The reader is referred to Daniele & Aldersley (1988) for a review of time and learning with the hearing-impaired. The BTES model uses academic learning time as a dependent variable. This construct may provide a way to explain the apparent efficiency of CAI. Computer-based instructional programs seem to be structured to decrease learning time and this reduction may result in improved efficiency as well as better performance on learning tasks.

A recent meta-analytic review of studies done with hearing-impaired subjects by Braden & Shaw (1987) has suggested that CAI is no better than alternative forms of instruction. The authors identified 287 references describing computer applications with deaf children. One hundred and sixty-two of these references investigated computers as an instructional tool with only 9% reporting efficacy data. The paucity of efficacy data was a prime reason for doing this research.

CAI ACHIEVEMENT AND LEARNING TIME

CAI has been in use for the last twenty-five years at most levels of instruction and in all subject areas as well. The effects of CAI on achievement have been summarized in a number of meta-analytic reviews. Hartley (1978) found that the average effect of CAI in mathematics elevated student achievement from the fiftieth to the sixty-sixth percentile.

Burns & Bozeman (1981) synthesized research results concerning the effectiveness of CAI mathematics instruction in elementary and secondary schools. Their results indicated a significant enhancement of mathematical achievement in those programs supplemented by CAI. Kulik, et al (1983) reported their meta-analysis of computer-based teaching for secondary students raised final examination

scores from the fiftieth to sixty-third percentile.

Kulik, et al (1980) performed meta-analysis on Computer-Based Instruction (CBI) for examination scores of college students, with the result that scores were raised from the fiftieth to the fifty-ninth percentile. Kulik (1981) concluded that the effectiveness of computer-based teaching is a function of instructional level at least in the area of mathematics education In general results seem to indicate that greatly improved performance with CAI is the exception.

In addition to the varying degrees of increased academic performance, several studies also report that CAI seems to accomplish objectives in significantly less time. The results are important not for their quantity but rather for their consistency. Molnar (1973) stated: "CAI permits students to achieve educational objectives in much less time and that saving in time of up to 40% is not uncommon" (p. 68). Cody (1973) agreed that "most of the studies ... indicate that material can be taught by computers in substantially less time than conventional techniques, with no loss in achievement" (p. 25).

Edwards, et al (1975) noted that nine CAI studies in which time was measured all reported that CAI produced equal or superior achievement in less time. Thomas (1979) reviewed ten CAI studies in secondary school settings and concluded "that CAI reduces the time required for a student to complete a unit" (p. 109). The content of the studies he reviewed ranged across mathematics, accounting, industrial arts, biology and typewriting. In the Kulik, et al (1983) meta-analysis, previously mentioned, the authors cite comparative data on learning time. Their review of Hughes (1973) indicated that students spent 135 minutes on instruction and study when taught with computers and 220 minutes when taught utilizing traditional methods and materials. Also their review of Lunetta's study (1972) revealed an 88% savings in time. Kulik, et al's (1980) analysis at the college level found that "In all of the cases in which investigators performed statistical tests (for eight studies reviewed on this variable), the differences in instructional time between Computer-Based Instruction (CBI) and conventional classes were statistically significant. On the average the conventional approach required 3.5 hours of instructional time per week, and the computer-based approach required about 2.25 hours. There is a substantial and highly significant difference between methods. There appears to be little doubt that students can be taught with computers in less time than with conventional methods of college teaching" (p. 537). Overton (1981) in a review of 50 CAI studies in mathematics noted that in two post-1975 studies CAI produced results faster than regular instruction. Jensen's (1982) study gave similar results for CAI instruction in addition for third grade students.

Why does CAI produce equivalent or positive results with respect to achievement and learning time? First the content is usually highly structured so that the objectives are more likely to be attained. Secondly, considerable attention is given to both identifying errors and giving immediate feedback to allow for remediation and for correcting misunderstandings (Cohen, 1985). In Jensen's (1982) study, it was

reported that CAI instruction of addition math facts to subjects resulted in a reduction of learning time because the computer software was programmed to generate practice problems that were causing difficulty. Computers can be programmed to initiate more substantive interaction when compared with the text in traditional instructional strategies. The questions, examples and problems generated by the computer require responses from the student and can be presented in small increments. The students must respond or key-in answers before moving on to the next step of a program. If the response is incorrect, the correct answer may be given after a number of trials or the correct set-up for solving a problem may be displayed on the screen. If the subject chooses, s/he may try 8-10 more examples or repeat an exercise again. Thus CAI is more substantive than traditional instruction in the sense that it provides immediate feedback and/or reinforcement on the correctness of a response as well as the individual student's overall progress and understandings. Carrier's (1988) study using the microcomputer for reading and writing skills of secondary school students focused on the inherent capacity of CAI to provide reinforcement by contrasting performance with a control group using printed exercises. She demonstrated a positive treatment effect when CAI was programmed to provide remediation practice that includes immediate learner reinforcement.

It has also been noted that CAI has the potential to increase the amount of time that learners are willing to spend because of its feedback capability and because the nonthreatening environment of the computer enhances the motivation of students. "The amount of time students are willing to spend with CAI materials ... is noticeably longer than with many other instructional materials. Students volunteer to give up other activities in order to complete CAI assignments, and teachers ... note almost immediately that students have to be pushed out of the computer lab at the end of the day" (Bright, 1983, p. 149). Bright (1983) suggests that "studies ... be conducted to determine if academic learning time is in fact increased and if there is a concomitant increase in achievement or decrease in clock time" (p. 150). Skinner's (1988) attitudinal survey study with college students recorded similar findings that were consistent with Carrier & Bright.

METHOD

The experimental design assessed the impact of CAI in a nontraditional educational environment utilizing an individualized, self-paced instructional approach in the treatments. In the evaluation, the educational delivery mode or treatment was varied, but the instructional approach remained constant (individualized and self-paced), allowing the real effects of the computer to be assessed. Specifically, this work was a comparative study, investigating the effect of two different treatments on the science performance and learning-time of hearing-impaired students. The experiment was conducted entirely in a classroom setting.

Subjects

The twenty-four hearing impaired students who participated in this study were enrolled in the National Technical Institute for the Deaf (NTID) at the Rochester Institute of Technology (RIT). These students elected to pursue a career in one of the three Allied Health Programs offered by the School of Science and Engineering Careers (SSEC). These programs include Medical Laboratory Technology (MLT), Medical Records Technology (MRT), and Optical Finishing Technology (OFT). The communication patterns of these students ranged from wholly manual (use of fingerspelling and/or American Sign Language (ASL)) to the completely oral method. Many employed varying combinations of the manual and oral modalities. Their educational preparation occurred at residential schools and/or day schools for the deaf or in public or private schools having special programs and support services for the hearing impaired. Some were mainstreamed in public school systems having no support services.

The average grade equivalent reading ability of the subjects was 8.61 years with a range from 6.1 to 11.6. The average pure tone hearing loss in the better ear was 95.6 dB and ranged from 73 to 120 dB (American National Standards Institute (ANSI), 1970). The age range of the sample was 18 to 28 years with an average of 20.7 years.

Procedure

Since subjects were assigned modules to read on different science topics, language proficiency in the form of reading skill as measured by the California Achievement Test (CAT) was an important variable in this research design. Reading skill is related to comprehension of text structures (e.g. vocabulary, syntax, and so forth) and this influences performances on reading tasks (Cassels & Johnstone, 1984; King & Quigley, 1985) and learning time (Fisher, 1978a & b).

Utilizing twenty-four students, two groups of 12 were formed based on scores received on the reading comprehension section of the CAT. The cut-off score was 8.4 . Twelve students at or below 8.4 were designated as the Low Proficiency reading group and the remaining twelve were referred to as the High Proficiency group. The two groups were then subdivided randomly for treatment. Six students were assigned to the Computer-Assisted Instruction (CAI) and Paper and Pencil (P/P) treatment from the high proficiency group. Similarly, the low proficiency reading group was subdivided so that each treatment contained six students. Twenty-four students, six per cell completed all assigned tasks.

Analysis of available Institute placement data indicated that these students were representative of the NTID population, being heterogeneous in terms of cause and age of onset of deafness, method of communication, and use of hearing aids. All groups were assigned the same content modules . A pre/post test composed of 75 questions was given at the start of the study and again when all the modules were

completed. The difference between the posttest and pretest scores made up one of the dependent variables called the pre/post gain score. The remaining measures consisted of ten module tests which also served as dependent variables on performance.

The treatment involved two methods of self-instruction. The first was the paper and pencil (P/P) method which required the reading of modules and writing on Study Sheets. These materials were then utilized for study and review for testing based on prestated objectives. The student was given the module and the time was recorded by the instructor. When the student finished reading the module, s/he requested a practice test and the instructor recorded the time again. After the students finished, the instructors recorded the times and scores. Students then proceeded to review the module and practice test in preparation for the module test. Finally, students took the module test which was graded and recorded. The CAI treatment involved reading the same modules, but the student interacted with the practice tests for study and review for module testing on the computer. The practice tests and module tests were the same as those utilized by the P/P groups.

The second independent variable was the language proficiency level, designated as high language proficiency and low language proficiency according to scores received on the California Achievement Test (CAT).

Hypotheses

Three null hypotheses were tested:

1. There are no differences between the means for the two treatments on the following:
    a) pre/post test gain scores
    b) module exam scores
    c) learning time records for:
        1. reading modules
        2. studying and reviewing modules
2. There are no differences between the means for the two language proficiency groups on the following:
    a) pre/post test gain scores
    b) module exam scores
    c) learning time records for:
        1. reading modules
        2. studying and reviewing modules
3. There is no interaction effect of treatment and language proficiency

on any of the dependent variables.

This study utilized a 2 x 2 factorial design. The two independent variables were treatment (CAI and P/P) and language proficiency (High Proficiency and Low Proficiency). The dependent variables were the scores and learning time recordings. The two way analysis of variance (ANOVA) provided a significance test for the main effect of each independent variable and for their interaction.

RESULTS

The calculated results for the performance scores on the modules that produced significant differences are summarized below. The values within each cell indicate sample size, subgroup mean and standard deviation from top to bottom, respectively. The row means for each of the treatments are shown at the right while the column means for language proficiencies are given at the bottom. A simple linear plot of the group means for each of the module data are shown immediately to the right of the tabulated descriptive statistics. Just below the descriptive statistics and plots are the analysis of variance summary tables. Only those modules for which significant F-ratios were found are shown. The descriptive and inferential data for time-on-task follow the same format.

For alpha ( ) = .05 at 1 and 20 degrees of freedom the critical value of F is equal to 4.35. Significant F-statistic values were obtained for the main effect of language on the performance test Module #3 (Atomic Structure). Statistically significant interaction effects were found for Modules #3, #4, and #6 (Atomic Structure, Periodic Table and Measurement).

[Insert Figure 1 here] **[Insert Figure 2 here]**

[Insert Figure 3 here]

More F-statistic values calculated for the time-on-task data exceeded the critical value than was the case with the performance data. The main effects of both treatment and language F-ratios were significant for Module #1 (Science of Chemistry). The F-ratio for the main effect of treatment was significant for Module #7 (Writing Chemical Formulas). The main effect of language proficiency was significant for Module #6 (Measurement) and the only significant interaction effect for the time-on-task data occurred with Module #3 (Atomic Structure).

[Insert Figure 4 here] [Insert Figure 5 here]

[Insert Figure 6 here] [Insert Figure 7 here]

The allocated time set for this study was projected to be five weeks. Each student was scheduled to meet in a specific room on specific days and times for five hours per week. This totaled 25 hours for completion of the project. Records of dates of starting for reading, practicing, studying/reviewing and testing were kept. The amount of time required to complete the tasks varied among the students. For example, one individual finished in 3.3 weeks, while another student required 8.3 weeks. The time span data were calculated by counting from the starting day to the date the post-test was taken. Saturdays and Sundays were included because some students arranged to work on the weekends, although few actually did. The results for project completion time may be examined below. The plot clearly shows that it took longer for the P/P groups to complete the project. There was an overall significant main treatment effect for these data.

[Insert Figure 8 here]

DISCUSSION

Performance Data

The expectation that the CAI treatment would produce higher mean scores on the performance measures was not supported by the results of this study. The ANOVA's done on all the performance modules produced no significant main effects of treatment for this sample of hearing-impaired students.

Only for Module #3 (Atomic Structure) was a significant overall F-ratio observed for the main effect of language on the performance data. The mean of the high language proficiency groups for the two treatments was significantly higher than the mean of the low language proficiency groups at the .05 level.

An interaction effect is a combined effect due to the contributions of the two independent variables. Figures 1, 2 and 3 indicate that Modules #3, #4 and #6 (Atomic Structure, Periodic Table and Measurement) produced significant interactions. In the case of Module #3 (see p. 6) the P/P-Low Proficiency group had a higher mean score than the CAI-Low Proficiency group while the CAI-High Proficiency group had a higher mean score than the P/P-High Proficiency group. The fact that the P/P-Low Proficiency group obtained a higher mean score than the Low Proficiency CAI group was not expected.

Modules #4 and #6 also resulted in significant interaction effects and no main effects. The mean differences that occurred followed the same trend as Module #3 (i.e. the CAI-High Proficiency groups had higher means scores than the P/P-High Proficiency groups and the P/P-Low Proficiency groups had higher mean scores than the CAI-Low Proficiency groups). Considering Modules #3, #4 and #6 together, it is noted that all three had significant interactions, with very similar patterns of cell means (see the data and the corresponding figures on p. 6).

The ANOVAs for the performance data for the high language proficient CAI group produced higher means for Modules #3 and #6, while the low language proficient CAI group had a time-on-task mean almost twice that of the high language CAI group on Module #6 (see p. 7). This result indicated that the high language proficient CAI group spent less time and performed better than the low language proficient CAI group on Modules #3 and #6. Examination of the time spent by these two CAI groups with respect to study/review time for these three modules indicated that the low proficiency language CAI group spent more time preparing for the module tests. Taken together, these results suggest that CAI may be advantageous for students having higher language skills and less beneficial for students with low language proficiency.

Time-On-Task Data

Although three of the ANOVA's resulted in significant main effects for treatment, not all of them supported the anticipated reduction in learning time found in most of the meta-analytic reviews cited. Perhaps this result is unique to the sample of hearing-impaired students in this study. The main effects of treatment for Modules #1 and #7 (Science of Chemistry and Writing Formulas) were significant with respect to time in minutes spent on these modules. The CAI groups in both cases had significantly higher mean times which indicate that these groups spent more time on these modules than the P/P groups. Module #1 represents the initial opportunity for computer interaction for the CAI groups. In this instance there may have been a novelty effect of a new activity producing the increase in the drill/practice time. The average time was almost 35 minutes compared to 20 minutes for the P/P groups.

The time-on-task results for Module #7 (Writing Formulas) were similar; a much greater amount of time was spent by the CAI groups (2.5 hours on the average compared with 1.7 hours for the P/P groups). This may be due to the stimulating nature of the CAI programs that induced these groups to continue practicing to increase their correct responses to the writing of formulas. These results for Modules #1 and #7 are consistent with Bright's (1983) findings that students were noted to be spending more time on CAI activities and the rationale for this may be tied to the capacity of CAI to provide more substantive instruction in terms of feedback and/or reinforcement on the responses as well as information on each individual student's overall progress.

In the case of the third significant main effect of treatment, the mean time in weeks was consistent with the findings of the studies reviewed in the literature (Edwards, et al, 1975; Thomas, 1979; Overton, 1981; Jensen, 1982; Kulik, et al, 1980,1983), namely that the CAI groups completed all the assigned modules on the average slightly more than two weeks earlier (see Fig. 8, p. 7). This occurrence could be the result of motivating factors inherent in the interactive nature of CAI. Although the CAI groups spent more time on each individual module, they completed all the learning tasks 2.1 weeks sooner than the P/P groups.

Significant main effects of language proficiency for the time-on-task data were found for Modules #1 and #6 (Science of Chemistry and Measurement). In both modules the high language proficiency groups had the lower mean times and thus completed these modules sooner. This was expected on all of the modules.

A significant interaction effect was found for Module #3 (Atomic Structure). This interaction followed the same trend found in the interactions on the performance data, the P/P-Low Proficiency group had a significantly higher mean score than the CAI-Low Proficiency group while the CAI-High Proficiency group had a significantly higher mean score than the P/P-High Proficiency group (see Fig. 5, p. 7). Again when taken together, these results suggest that CAI may be advantageous for students having higher language skills and less beneficial for students with low language proficiency.

CONCLUSIONS

There were no statistically significant differences between the mean scores for treatment for the pre/post test gain scores and the module exam scores. The findings of this study did not support the results of previous work (Burns & Bozeman, 1981; Kulik, et al, 1980,1981; Smaldino, Schloss, Goldsmith, & Selinger, 1983; Carrier, 1988). The null hypothesis was rejected with respect to the main effect of language proficiency on Module #3 and was accepted for the rest of the modules. The null hypothesis was also rejected for the interaction effects for Modules #3, #4 and #6 and was accepted for the remaining modules.

The null hypothesis for Modules #1, #7 and the data for Project Completion time-on-task data were rejected for the main treatment effect. The null was accepted for the remaining module time-on-task data. The means of the CAI groups were larger than the P/P groups, indicating that more time was spent working on the modules by the former groups. These results did not support the findings of Molnar (1973), Jamison, et al (1974), Edwards, et al (1975), Jensen (1982) and Kulik, et al (1980,1983), but was consistent with Bright's (1983) in that students spent more time with CAI materials compared with use of traditional instructional materials. Both groups of hearing-impaired CAI subjects spent more time with the computers. The nature of the programs, feedback, motivation and a non-threatening environment

are just a few of several possible explanations.

The CAI groups completed all nine modules 2.1 weeks sooner (on the average) than the P/P groups . This result is consistent with the majority of previous studies cited above. The observed long-term effect of reduced time-on-task for the CAI groups can be explained in terms of the motivational environment of CAI. Each subject was scheduled to work on the modules five hours per week for five weeks. Fewer individuals in the CAI groups missed their sessions compared with the P/P groups. The inherent interactive nature of a CAI environment (i.e. immediate feedback, and/or reinforcement on the correctness of responses, non-threatening testing sessions, etc.) is one plausible motivating factor that induced the CAI groups to complete all nine modules 2.1 weeks earlier than the P/P groups.

The null hypotheses for the main effects of language were rejected for Modules #1 and #6. Both High Proficiency groups had lower means and finished sooner than the Low Proficiency groups. Examination of the time records indicate that a few individuals in the Low Proficiency groups clocked large times for these modules, so these results were influenced by the small group sizes. There was an interaction effect for Module #3 with the time data. The time records support the influence of large differences in clock time for a few individuals.

In sum, the results of this study indicate no differences with respect to treatment on the performance scores of the samples. The CAI groups took longer to finish the modules but completed the learning tasks sooner than the P/P groups. These findings should be considered cautiously because of the limited sampling design. Future studies may differ from these findings with diverse hearing-impaired populations and curricula. The potential of CAI for the hearing-impaired can be evaluated only through empirical studies such as this.

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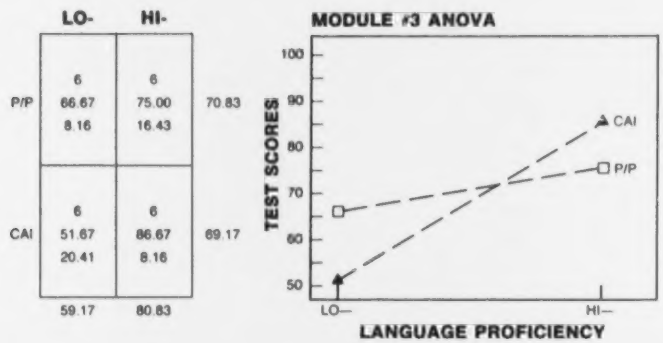
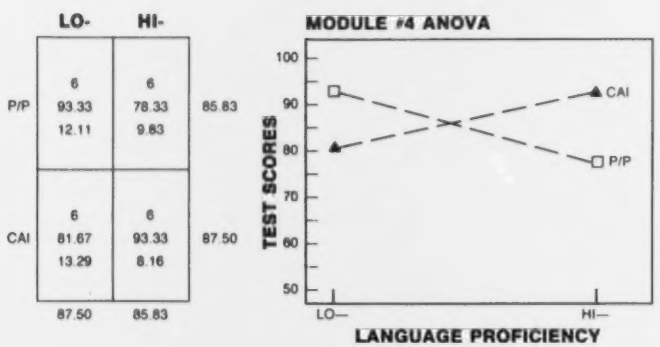


SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F
Treatment	16.667	1	16.667	.081
Language	2816.667	1	2816.667	13.740*
Treatment x Language	1066.667	1	1066.667	5.203*
Error	4100.000	20	205.000	
TOTAL	8000.000	23		

* = Significant

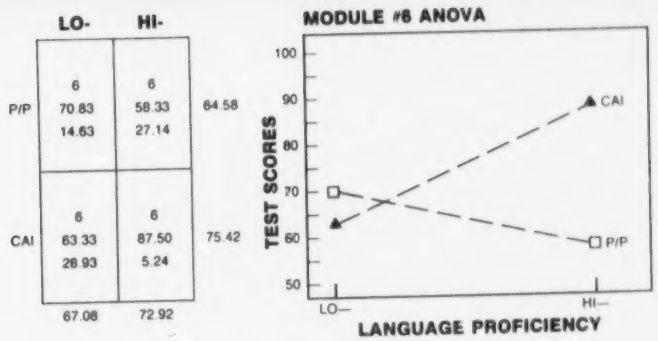
FIGURE 1. PERFORMANCE DATA - MODULE 3 (ATOMIC STRUCTURE)



SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F
Treatment	16.666	1	16.666	.137
Language	16.666	1	16.666	.137
Treatment x Language	1066.667	1	1066.667	8.767*
Error	2433.333	20	121.667	
TOTAL	3533.333	23		

* = Significant

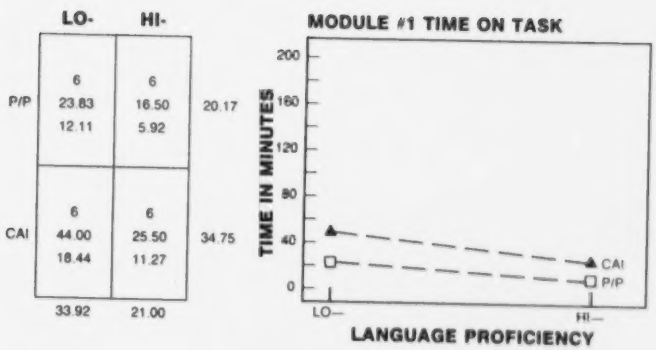
FIGURE 2. PERFORMANCE DATA - MODULE 4 (PERIODIC TABLE)



SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F
Treatment	704.167	1	704.167	1.552
Language	204.167	1	204.167	.450
Treatment x Language	2016.667	1	2016.667	4.444*
Error	9075.000	20	453.750	
TOTAL	12000.000	23		

* = Significant

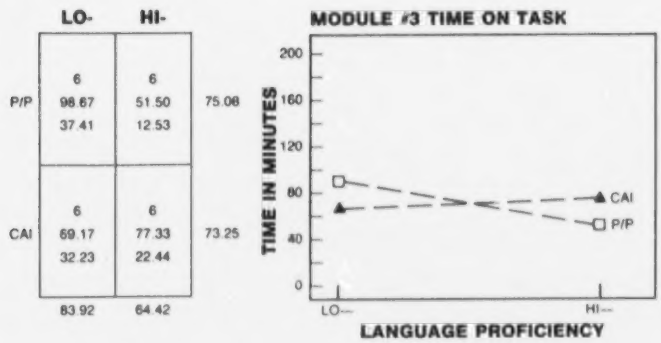
FIGURE 3. PERFORMANCE DATA - MODULE 6 (MEASUREMENT)



SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F
Treatment	1276.042	1	1276.042	7.867*
Language	1001.042	1	1001.042	6.172*
Treatment x Language	187.042	1	187.042	1.153
Error	3243.833	20	162.192	
TOTAL	5707.958	23		

* = Significant

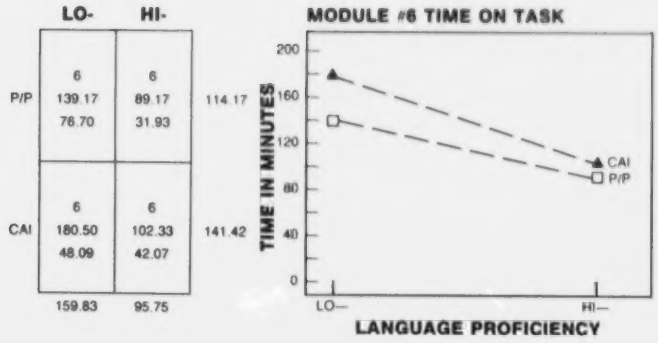
FIGURE 4. TIME-ON-TASK DATA - MODULE 1 (SCIENCE OF CHEMISTRY)



SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F
Treatment	20.167	1	20.167	.026
Language	2281.500	1	2281.500	2.945
Treatment x Language	4592.667	1	4592.667	5.929*
Error	15493.000	20	774.650	
TOTAL	22387.333	23		

* = Significant

FIGURE 5. TIME-ON-TASK DATA - MODULE 3 (ATOMIC STRUCTURE)

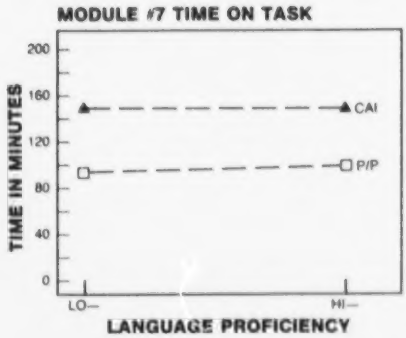


SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F
Treatment	4455.375	1	4455.375	1.622
Language	24640.042	1	24640.042	8.972*
Treatment x Language	1190.041	1	1190.041	.433
Error	54924.499	20	2746.225	
TOTAL	85209.958	23		

* = Significant

FIGURE 6. TIME-ON-TASK DATA - MODULE 6 (MEASUREMENT)

	LO-	HI-	
P/P	6 97.67 44.51	6 102.67 54.04	100.17
CAI	6 151.67 51.20	6 150.17 54.48	150.92
	124.67	126.42	

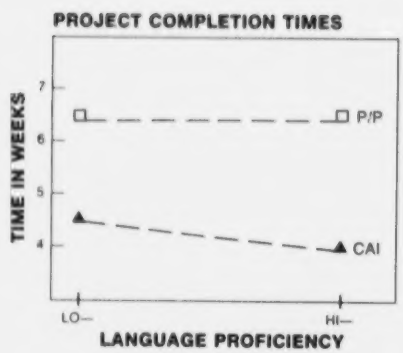


SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F
Treatment	15453.375	1	15453.375	5.892*
Language	18.375	1	18.375	007
Treatment x Language	63.375	1	63.375	024
Error	52458.833	20	2622.942	
TOTAL	67993.958	23		

* = Significant

FIGURE 7. TIME-ON-TASK DATA - MODULE 7 (WRITING FORUMLAS)

	LO-	HI-	
P/P	6 6.43 1.55	6 6.55 1.94	6.49
CAI	6 4.55 79	6 4.17 .78	4.36
	5.49	5.36	



SOURCE	SUM OF SQUARES	DF	MEAN SQUARE	F
Treatment	27.264	1	27.264	14.706*
Language	.104	1	.104	.056
Treatment x Language	.375	1	.375	.202
Error	37.089	20	1.854	
TOTAL	64.832	23		

* = Significant

FIGURE 8. PROJECT TIME DATA (WEEKS)